SPECIAL COMPARATIVE REPORTS.

Summit.—The following table shows depth of snow on ground at Summit on several dates in April for a number of years:

	Apr. 1.	Apr. 15.	Apr. 30.
	Inches.	*Inches.*	*Inches.*
1907	240	165	117
1908	50	31	23
1909	188	158	129
1910	65	32	12
1911	135	146	96
1912	50	30	29

SUNSHINE.

The following table gives the total hours of sunshine and percentages of possible:

Stations.	Hours.	Per cent of possible.	Stations.	Hours.	Per cent of possible.
Eureka	141	35	Sacramento	222	56
Fresno	304	77	San Diego	238	61
Los Angeles	250	64	San Francisco	192	49
Mount Tamalpais	206	52	San Jose	240	61
Red Bluff	189	48	San Luis Obispo	214	55

There was less sunshine during the current April than during April last year.

NOTES ON THE RIVERS OF THE SACRAMENTO AND LOWER SAN JOAQUIN WATERSHEDS DURING APRIL, 1912.

By N. R. TAYLOR, Local Forecaster.

Sacramento watershed.—For the fifth consecutive month the rivers of the Sacramento drainage basin have been exceptionally low. Previous low-water records for the month were broken at all points, except at Red Bluff on the Sacramento, where the river averaged 0.4 of a foot above the low water of 1908. At Colusa, Knights Landing, and Sacramento City the Sacramento averaged from 7 to nearly 10 feet below the stages usually maintained during the month in question.

In the Feather, Yuba, and American watersheds all streams averaged the lowest on record for April.

The rainfall throughout the Sacramento Valley was deficient generally, and the amount which fell had little effect on stream flow. The greatest rise reported was at Colusa, where the river rose slightly over 3 feet during the 24 hours ending at 7 a. m. of the 12th.

Lower San Joaquin watershed.—While less than the normal amount of rain fell in this watershed, the shortage was not so marked in the higher regions as in the floor of the valley. The effect of rainfall on stream flow, however, was barely apparent in any of the rivers, all of which averaged lower than for any corresponding month of which there is a record. The San Joaquin itself, from Lathrop to the mouth of the Calaveras, averaged over 10 feet below the mean stage of the past 13 years, and was over 6 feet below the previous low-water stage for April.

NOTES ON THE RIVERS OF THE UPPER SAN JOAQUIN WATERSHED.

By W. E. BONNETT, Local Forecaster.

The stages of the streams of the Upper San Joaquin watershed continued to be extremely low during April. They were much lower than the lowest previous stages for this month in the six years of record. At Merced Falls, on the Merced River, the mean stage was 0.9 foot, as compared with a mean stage of 1.7 feet for the last six Aprils. Following some good rains on the 9th, 10th, and 11th the river at this point rose to 1.5 feet, the maximum stage of the month.

Similar conditions obtained on the San Joaquin. The mean stage at Friant was but 0.3 foot and at Firebaugh −0.4, as compared with six-year averages of 2.4 feet and 5.2 feet for these stations, respectively. The highest stage at Friant occurred on the 11th and at Firebaugh on the 13th and 14th.

At Piedra, on the Kings River, and at Three Rivers, on the Kaweah, the highest stages for the month also occurred on the 11th, but they were only a few tenths of a foot higher than the low stages which immediately preceded that date. The stages in these streams were low and remarkably uniform throughout the month.

From the irrigators' viewpoint the streams have been disappointingly low. Several canals, particularly those served from the Kings River, which by judicial decision are not entitled to water until the stream has reached a certain stage, so far this season have been without water because the stream has not risen above the required stage.

NEW HEATER AND VAPORIZER FOR FROST PROTECTION.

(Advance copy printed in Pacific Rural Press, Apr. 27, 1912.)

By Prof. A. G. McADIE, U. S. Weather Bureau.

Various types of heaters and smudgers were described in Bulletin No. 29, United States Weather Bureau, entitled, "Frost Fighting," issued March 13, 1900.

The first heater used, so far as our knowledge goes, was the wire basket coal burner of Copley, at Riverside, Cal., in the winter of 1895–96. The first oil burner was used in California in the winter of 1900–1901. Since then many burners and orchard heaters have been devised, and there are now on the market 17 or more types of orchard heaters, most of them oil burners.

There has naturally been competition among the makers, and claims of superiority are published and widely distributed in fruit-growing States. It may be said that nearly all of the heaters are serviceable and that there is no longer any doubt concerning their protective value. The problem now is one of higher efficiency, together with cleanliness of method and ease of handling. There are two ways in which improvements can be made, one by securing a more uniform and more complete combustion, and the other (closely connected) by decreasing the amount of soot. Crude oil is unquestionably the cheapest fuel where combustion methods are used, although we believe covers are most economical in the long run. Tests by Lewis and Brown, in 1910, and by O'Gara, in 1911, show that crude oil is best per unit of cost; but the method is not a clean one, and if the orchards are located in a thickly settled community, as is the case with the orange groves of California, vigorous objection is made to the soot. Moreover, greater uniformity in the rate of combustion is desirable. With many of the present types of orchard heaters, especially the open-pail variety, the rate of combustion decreases with the time of burning. Soot arresters do not help, but rather make matters worse; and there is constant complaint that after burning a few hours the amount of heat given off is much diminished, and this at a time when heat is most needed.

With a view to meeting the above objections, two new methods are being tried at the local office of the Weather

Bureau, San Francisco. In one an improved burner is used with kerosene or some light oil as a fuel. There is also a surrounding shallow pan of water which is slowly vaporized. In the second device an electric current is employed to vaporize water. The former of these two devices will be described in this article and the latter in a subsequent paper.

The new burner is made of cheap combustible material, and there is comparatively little ash or residue left. There is no asphaltum or slag, as is the case with crude oil used on the Pacific coast. The amount of soot given off, while appreciable, is very much less (probably one-fourth or one-fifth) than that from heavy oils. The two objects sought to be obtained are, first, minimizing the amount of soot, and, second, providing a uniform rate of combustion.

The burner consists of a cardboard tube 1 inch or more in diameter. This tube is loosely packed with cotton waste, small tufts projecting at each end. When soaked with kerosene this makes an excellent wick. An ordinary fruit can, capacity 1 quart, with detachable cover, serves as a fuel holder. A hole is cut in the cover just large enough to permit the insertion of the cardboard tube. The can is nearly filled with kerosene and placed within the larger can, capacity 5 gallons. This larger can has a small opening on one side to regulate combustion and is open at the top. In practice we have used old kerosene cans. A supply of water is poured into the outer can to a depth of several inches.

The purpose of using water is twofold. First, to prevent undue heating of the outer can and thus moderate the heat, and second, to make use of the latent heat of vaporization. By supplying an increased amount of water vapor at a moderate temperature we furnish a medium which has a high absorption value for the long heat waves radiated from the soil, approximately 0.012 mm. wave length. Such an agency prevents rapid cooling through free radiation, which probably is the source of greatest loss of heat from both leaf surface and soil during frost periods. The vapor also serves to prevent a too rapid warming in the morning hours, inasmuch as the solar energy is at first utilized in doing the work of changing condensed vapor or water into invisible vapor.

We have practically an oil pot in a water jacket. By placing the cans vertically one on top of another we can bring, if desired, the level of the source of heated air and heated vapor nearer the level of the fruit, and thus minimize the loss of heat which now takes place with burners of the single type resting on the ground. This is an important point because at the present time, with a hundred burners to the acre, using a gallon each of oil, something like 15,000,000 British thermal units or 3,760,000 calories would be given off, provided the combustion was perfect, which of course is never true. Now, to raise the temperature of the air 1° F. over an acre to a height of 15 feet is practically heating 653,400 cubic feet of air. In practice it is found that to maintain the temperature on a still night 1° above freezing requires 0.252 calories per hour per cubic foot. Therefore for a period of 7 hours, which is about the average duration of the low temperature, although 10 hours is a safer period, there will be required 1,138,200 calories. And if a raise of 5° is required it is evident that more than 5,500,000 calories are needed; or more than the full number of heat units in the fuel under perfect combustion. It is evident that we must reduce the mass of air to be heated and apply the heat to those portions of the air in the vicinity of the fruit or plant to be protected. This will materially improve the efficiency of the protective device, as there is no gain in warming up all out-of-doors. This is the weakness of large fires, where the heat is carried by convectional currents to levels 30, 50, or 100 feet above the ground. For purposes of protection this heat is wasted.

Nor is it necessary to warm the lowermost strata. It is enough to warm the layer between 6 and 15 feet above the ground. As is well known, the level of the tree tops is generally warmer than the levels near the ground. In the new device we seek to provide a layer of water vapor at or about the level of the tree top. The cold air that has settled to the ground should not be displaced, but allowed to remain. The mixture of warmed air and warmed vapor rising from a source 5 or 6 feet above the ground will not displace the colder, drier, and more dense air near the ground. The problem is essentially one of proper utilization of the heat available. In our present methods there is great extravagance in the use of heat.